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REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL

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	Specifications	Procedures	TITLE	
Engrg			SPECIFICATION FOR 66" f/5 PANORAMIC CAMERA SUBSYSTEM	9040
Engrg	25X1			
Engrg				
[illegible]	[redacted]			
Project				
QA App'd				
SE App'd				55155
Issued	7 MARCH 1963			Sheet 1 of 22

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1.0 SCOPE

1.1 Objective: This specification covers the requirements for a high-acuity panoramic camera as defined in Systems Requirements Specification SP2-126. The panoramic camera is to provide programmed vertical and stereo photographs [redacted] The system is to be designed to be used in a light-tight structure and will allow recovery of the film only. 25X1

2.0 APPLICABLE DOCUMENTS

2.1 The following publications of the issue in effect as of date of issue indicated, shall form a part of this specification to the extent specified herein. In the event of conflicting provisions, the requirements of this specification shall prevail. See Appendix A.

Specification Number	Title	Date of Issue
MIL-STD-150A	Photographic Lenses	12 May 1959
6117B	Environmental Test, Specification	1 July 1960
MIL-E-1D	Electron Tubes and Crystal Rectifiers	31 March 1958
447969A	Systems Electrical Interface Specification	9 April 1962
1072045D	Cable Design Control Specification	8 December 1960
SP2-156C	Electrical Interface	9 September 1962
T55-100	Interface Drawing	14 July 1962
43704F	Format Drawing	17 July 1962
SP-0004A	Process Specification, Film Type SO-132	
SP2-126	Systems Requirements Specification	3 April 1962
49346A	Spooled Film	14 September 1962
TD-55	Semi-Conductor X-ray Inspection	
1326684A	Mirror, Metal	20 July 1961

3.0 REQUIREMENTS

3.1 General

3.1.1 General Requirement: The cameras shall conform to the requirements of this specification.

3.1.2 Parts, Materials, Processes: Shall be consistent with flight objectives and good design practices. When and where applicable, MIL standards and specifications for space equipment shall be used as a guide.

3.1.3 Weight: Total weight of the panoramic camera including empty supply spool but excluding cassette shall not exceed 627 pounds. Maximum film capacity will be 75 pounds. The cassette shall not exceed 17 pounds.

3.2 Selection of Specifications and Standards

3.2.1 Standard Parts: AN or MIL standard parts shall be used wherever possible.

3.2.2 Commercial Parts: In applications for which no suitable corresponding AN or MIL part exists or where they are not readily available, qualified commercial parts may be used.

3.3 Material

3.3.1 Metals: Metals shall be of the non-corrosive type or be suitably protected (subject to the thermal requirements) to resist corrosion during maximum service life. (Test, storage, and flight.)

3.3.2 Semi-Conductors: The following ground rules apply in the selection of semi-conductors:

3.3.2.1 Requirements and characteristics of MIL-E-1D must be considered minimum, and no component shall be used that is not vendor-certified or tested to the limits of that specification.

3.3.2.2 The environmental requirements of 6117 may be used as minimum levels, provided sufficient de-rating is applied to verify thermal competence.

3.3.2.3 All semi-conductors must be X-ray inspected, per TD-55.

3.3.3 Electrical: Interface power and power distribution characteristics shall be as specified by 447969, System Electrical Interface. 447969 shall be used as a guide for Camera System power and signal distribution, shielding, and grounding.

3.4 System Design Objective: The camera subsystem shall satisfy the high-acuity, panoramic camera concept and shall include a take-up cassette which will be independently mounted in a recovery capsule. Electrical circuits, controls, and cycling programmer capable of operating on commands from the vehicle programmer shall be included. Instrumentation which will provide inputs to the vehicle telemetry system to monitor critical functions of cameras while in flight will be established as indicated in SP2-156.

3.4.1 Photo Quality: Panoramic photographs will be of such quality as to permit the resolution of an adequately illuminated Air Force test pattern at a level of [redacted] Tests shall be conducted for qualification and acceptance of equipment using an Air Force test pattern of the type defined in MIL-STD-150A. Target contrast shall be that required to present 2:1 contrast at the camera mirror. 25X1

3.4.2 Location Accuracy: The system design objective for location accuracy of any point on the panoramic photograph shall be ± 2 miles. 25X1

3.4.2.1 Time recording to an accuracy of [redacted] will contribute a maximum uncertainty of [redacted] 25X1 25X1

3.4.2.2 Positioning of the optical axis to within [redacted] minutes of arc will result in a possible error of [redacted] 25X1

3.4.3 Lifetime: The mission life will be one to four days during which photographs can be taken at intermittent times.

3.4.4 Swath Width: The panoramic camera shall provide ability to photograph selected target areas having a nominal swath width corresponding to a scan angle of [redacted] degrees, and having photographic quality per paragraph 3.4.1. Additional scanning for acceleration and deceleration may be necessary. 25X1

3.4.5 Stereo: Stereo photography will be 8 frames forward and 8 aft along the vehicle flight path. There will be a dead zone between photographed areas equal in length to the length of the

25X1 target photographed. The stereo will have a fore and aft convergence angle of [redacted] degrees. The camera shall be capable of vertical photography and may be commanded in flight to provide stereo photography. Stereo mode shall be primary; therefore monoscopic mode shall be secondary.

3.4.6 Roll Positioning: Roll positioning of the camera will be provided for selection of targets not directly beneath the flight path. The maximum roll angle to be provided will be [redacted] degrees. 25X1
A signal indicating the angle of roll with respect to vertical will be provided in five (5) discrete positions [redacted] to allow 25X1
correction of the IMC system and to film-record the roll angular command in the auxiliary data block. The nominal response time for cam positioning
25X1 shall be [redacted] seconds from [redacted] roll. 25X1

3.4.7 Scan Overlap: Approximately 10 percent overlap at nadir between successive panoramic scans shall be provided.

3.4.8 Operate Cycle: 16 scans shall constitute a minimum basic panoramic camera operating cycle. Additional camera start pulses will be required to continue operation in periods of 16 frames.

3.4.9 Continuous Cover: Once placed in operation, the cameras shall have the ability to operate in a continuous manner
25X1 for a maximum of [redacted] minutes during the mission duty cycle.

3.4.10 Programming: The orbital programmer will be used for commanding operation.

3.4.11 Environmental Performance: The camera subsystems shall perform within the limits established in this specification when exposed to any natural combination of the environments specified.

3.5 Vehicle, System Characteristics, and Interfaces

3.5.1 V/h for IMC: Ground selection of a suitable time varying V/h ramp will be required via real time command. The median velocity/altitude ratio shall be [redacted] radians per second. The 25X1
system will be capable of accepting commands in the V/h range [redacted] to 25X1
25X1 [redacted] radians/second and will accomplish IMC. A minimum of 10 ramps will be provided. These ramps will be adjusted prior to flight to narrow the design V/h range by a factor [redacted] for improved V/h accuracy. Ramp 25X1
repeatability, once set, shall be [redacted] percent. The system shall be 25X1
capable of operating on both increasing and decreasing V/h conditions. The assignment of ramps as increasing or decreasing functions must be made prior to flight.

3.5.2 Vehicle Stabilization Requirements

3.5.2.1 Angular Deviations

Roll ± 1 degree

Pitch ± 3 degrees

Yaw ± ½ degree (corrected for earth's rotation).

25X1 Capability to change the yaw of the vehicle from [redacted] degrees at a rate of [redacted] degrees/minute commensurate with the inclination angle will be provided by the associate. 25X1

3.5.2.2 Residual Angular Velocities

25X1 Roll and pitch [redacted] degrees/minute 25X1

Yaw [redacted] degrees/minute

3.5.2.3 Momentum Balancing: No momentum balancing is to be provided. Panoramic camera supply and take-up spools shall be counter-rotating.

3.5.3 Camera Compartment Environment

3.5.3.1 Pressure: The camera compartment will be unpressurized.

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3.5.3.2 Temperatures: During photographic operation, temperature of the panoramic camera shall be maintained at 75 degrees F [redacted] degrees F. Gradients on the take-up cassette ranging from [redacted] degrees F to [redacted] degrees F can be expected during recovery. Gradients and transients affecting lens and structure maintaining focal length will be controlled to tolerable levels by thermal design. Thermal design shall: 25X1 25X1

a. Establish the same uniform ambient temperature of the lens cell and the platen support tube to aid in maintaining focus using passive thermal control wherever possible.

b. Minimize mirror temperature gradients.

c. Provide cooling for camera electronics and electromechanical devices.

d. Provide thermal protection for the film near heat sources greater than 150 degrees F and maintain thermal stability of film areas.

[redacted]

To assure stable operational temperatures, emissive coatings and thermal insulation will be applied on those areas of the camera structure and components as shall be mutually agreed upon by Itek and the associate. Specific power dissipating components and temperature-sensitive components or subassemblies shall be the subject of special consideration for negotiation by the associate contractors with System Engineering.

3.5.3.3 Light-Tight: The associate structure which serves as a camera compartment will be constructed in such a manner as to prevent light other than image forming light from falling on and exposing the film at any time. Light boots within the camera to meet this requirement will be provided by Itek.

3.5.4 Auxiliary Data Film Record

3.5.4.1 Time Signal: A digital clock (associate-furnished) will operate in conjunction with the camera subsystem for supplying signals for illumination of 29 lamps in the data blocks of both the panoramic and the stellar/index cameras. It will be capable of storing time unambiguously for a period of 5 days in increments of [redacted] second or less. A readout will be provided to transfer the clock reading to the film once per frame, and a serial binary readout will be provided to transfer the clock reading via the telemeter. The clock error will not exceed [redacted] milliseconds in any 12-hour period after accounting for clock drift and offset. Clock readout will be initiated by lens scan angle at center of format and clock readout must be exposed in [redacted] milliseconds or less. The maximum repetition rate of the panoramic clock interrogate signals is approximately [redacted] seconds per cycle. Clock output will be 15V ± 1/2V. Output pulse duration shall be adjustable from [redacted] milliseconds.

3.5.4.2 Stereo: Three lights indicating mirror position will be provided.

3.5.4.3 Roll Steering: Three lights indicating IMC cam angular position will be provided.

3.5.4.4 Film Information: An edge mask shall be provided for photo-recording fiducial and shrinkage marks, and picture format in accordance with Itek drawing 43704.

3.5.4.5 Attitude Information: The stellar camera, of the stellar/index camera subsystem will supply photographic records of roll and pitch positioning to [redacted] degree accuracy.

3.5.4.6 Scan Rate: Scan rate shall be determined from

film data to at least [redacted] accuracy.

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3.5.4.7 End of Pass: 4 lights.

3.5.5 Electrical Power: SP2-156 delineates the electrical connectors that shall be provided.

3.5.5.1 Electrical Power (Maximum):

Power Source	V/h Generator	Cassette Heater Power	Required Camera Avg. Pwr. During Operate	Total Avlb. Energy During 100/hr. Flg. incl. Htrs.
[redacted]				

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*as programmed

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3.5.5.1.1 Starting Transient: Maximum starting transient load on the unregulated DC supply shall not exceed [redacted] watts and shall be limited in duration to a maximum of [redacted] at the beginning of each operate period.

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TITLE
SPECIFICATION FOR 66" f/5
PANORAMIC CAMERA SUBSYSTEM
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3.5.5.1.2 Recurring Peaks: Maximum recurring peaks shall not exceed 1000 watts of unregulated DC not exceeding 500 millisecond duration during camera operation.

3.5.5.1.3 Noise Level: Past experience has indicated that considerable noise may be present in these sources. All electrical circuits and controls should be designed to be capable of operating in the presence of noise as high as 2.0V (peak-to-peak) due to 2000 cps regulation on the plus and minus regulated DC power supplies. Transients of ± 10 volts of 10 millisecond duration may be experienced.

3.5.5.1.4 Ascent Phase: If required during ascent, the vehicle will supply [redacted] watts of +28 volt unregulated power continuously and [redacted] watts of +28 volts regulated power immediately after launch to the camera subsystems. Should this power be required, all tests will be performed under simulated conditions of power. 25X1 25X1

3.5.6 Programmer: Camera ON/OFF operation using "auto cycle" pulse command, V/h programmer synchronization, stereo/mono mode, discrete roll positioning command signals and stellar/index ON/OFF commands shall be provided by the command programmer. An "auto cycle" mode of 16 frames will be initiated upon receipt of a command pulse (0.05 minimum to 0.50 maximum second duration). Each additional continuing operation requires an additional pulse occurring not sooner than [redacted] seconds after the first pulse and not later than [redacted] seconds prior to normal camera shutoff after 16 frames at maximum V/h. Number of scans during auto cycle is identical for both stereo and mono modes. 25X1 25X1

3.5.7 Commands: Signals for the operation of the equipment must be obtained. The operation signals to be provided are as follows: 25X1

COMMAND	SIGNAL SOURCE	LOAD
Panoramic burst pulse	1 relay	[redacted]
V/h - IMC - Selection of best time function for internal V/h approximation. A pulse train signal will make this selection via real time command.	Command link	
V/h Generator Command (ON/OFF)	1 relay	

[redacted]

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COMMAND	SIGNAL SOURCE	LOAD
Stereo/mono mode selection	1 relay	[redacted] max.
Roll Steering IMC cam control (during time camera rolled)	3 binary-coded relays	max.
Stellar/index intervalometer command (ON/OFF)	1 relay	max.
Pan Command Reset	1 relay	max.

3.5.8 Stellar/Index Control and Programming: The associate shall provide a signal to initiate and continue operation of the Stellar/Index Camera Subsystem, as required throughout the mission. The panoramic camera will act as the intervalometer, proportional to V/h, and provide all subcycle commands required by the stellar/index camera, whether or not panoramic photography is being accomplished. Stellar/index photography will be accomplished at a ratio of one exposed frame for every ten panoramic cycles and expose no more than three (3) S/I frames for each sixteen (16) frame bursts of the panoramic instrument. The S/I camera shall operate whenever the main instrument operates independent of whether or not an "intervalometer" command is received. The S/I camera can operate without the main instrument by applying "intervalometer" command. This ratio provides [redacted] percent overlap at all V/h ratios.

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3.6 Design: The panoramic camera is intended to provide high resolution stereoscopic or monoscopic photographs of selected target areas. It is an integral system whose operation shall be sequence-programmed and automatic upon command, including film transport, scanning, IMC, and auxiliary data recording. The basic design (Hyac-type panoramic) utilizes a curved focal plane arc containing stationary film with panoramic scanning accomplished by rotation of the lens about its nodal point. It will accomplish both vertical and fore and aft stereo photography by tilting a mirror.

3.6.1 Configuration: The design of the camera shall be such so as to permit installation in an envelope as defined by Drawing Number T55-100.

3.6.2 Mechanical Interface: In accordance with Drawing Number T55-100.

3.7 Construction: Within the limits of weight and space available, construction techniques, processes, and materials shall be

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selected to provide the maximum in structural integrity for the environment to be encountered.

3.7.1 Suspension: The principle parts of the camera shall be designed for the panoramic camera to be operated as an integral unit. The principle parts of the camera are the lens drive assembly, mirror and drive assembly, shutter platen assembly, film transport mechanism including supply spool, film "dancer" loops and associated parts and drive mechanism, and a take-up cassette including spool and drive located in the recovery capsule. The panoramic camera shall be supported by the external skin of the vehicle and held in such a way to maintain alignment with the cassette and the stellar/index subsystem, per T55-100.

3.7.2 Maintaining Focus: The support of the film platen shall establish and maintain the distance from the lens nodal point to the film to the accuracy required to attain the specified resolution. Construction of the lens cell, the structure maintaining focal length and the platen assembly shall ensure that the spacing from lens to film will not be changed due to launch acceleration, vibration, and shock. The construction and materials shall maintain focus during and subsequent to the uniform ambient temperature variations expected.

3.7.3 Film Thermal Shielding: Film paths and equipment near high-temperature external skin shall be properly thermally shielded if required.

3.8 Performance:

3.8.1 Photographic Quality: The high-acuity panoramic camera, when operated, will produce a minimum degradation of static lens-film resolution. The design objective shall be 90 percent of the static AWAR lens-film resolutions obtained on the Mann Bench. The camera shall produce photographs with an AWAR resolution of [redacted] lines/mm or greater when operated under simulated flight condition utilizing the DRT with a moving Air Force Test Pattern as defined in MIL-STD-150. Target contrast shall be that required to present 2:1 contrast at the camera mirror. 25X1

3.8.2 Image Motion Compensation Accuracies: The forward motion compensation mechanism and the scan drive system shall have performance compatible with the design requirement pertaining to photographic quality and five (5) to fifteen (15) percent overlap.

3.8.3 Lens Drive Smoothness: The lens drive system, which is used for focal plane scanning in addition to forward

[redacted]

motion compensation shall be smooth such that no objectionable banding occurs on the photography of ground scenes. For measurement purposes, the amount of banding present will be determined using a stable diffuse DC light source or a strobe light.

3.8.4 Exposure Control Evenness: Banding caused by non-uniform lens motion shall be controlled to produce less than [redacted] Log E change in exposure. The Delta Log E exposure change shall be determined by reference to the straight-line portion of SO-132 sensitometric control film printed and normally processed with the banding exposure test per Specification 0004, Process Specification.

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3.9 Major Components: The high-acuity panoramic camera shall consist of:

3.9.1 Film

3.9.1.1 Base: The camera shall be designed to utilize SO-132/130 or equivalent thin base (0.0035-inch) polyester film. Use of polyester materials varying in thickness between 1.8 and 4 mils will be a design objective.

3.9.1.2 Emulsions: The camera will be capable of handling and exposing Eastman Kodak films Special Order 132/130 or other films having equivalent or better photographic emulsions and physical properties.

3.9.1.3 Width: The system will use 5-inch wide film.

3.9.1.4 Spooled Film: The spooled film shall be in accordance with Itek Specification 49346.

3.9.1.5 Format: The format will be in accordance with Itek Drawing Number 43704.

3.9.2 Film Transport System: Film will be stored on supply and take-up spools. During camera operation, these spools will be driven at essentially constant speed which will be determined by the required cycling rate. (Proportional to V/h.) An intermittent transport system will meter unexposed film into the platen area between photographic scans. The film on the platen will be held stationary during the scanning portion of each cycle. Dancer loops will be utilized to store film supplied and taken up during scan. Supply and take-up spools will be controlled in a manner to maintain the proper amount of film in the dancer loops, thus

preventing slack loops or excessive film tensions. The film path will be designed to ensure proper tracking of the film and to eliminate the possibility of film tear or damage to the emulsion. The film transport system will be designed to minimize static discharge in the active format area in aerial scenes.

3.9.2.1 Allowance for Film Splices: The film handling system and guides shall be designed to allow for smooth passage of the required number of proper film splices expected in each roll of operational film. The film transport shall be capable of passing film that has been properly butt-spliced with 1-inch wide polyester film tape (Minnesota Mining and Manufacturing Company, Type Number 850 or equivalent.)

3.9.2.2 Space Between Formats: The space between adjacent formats will be utilized for data recording. The maximum space permitted between picture formats shall be in accordance with format drawing 43704.

3.9.2.3 Rollers: All rollers in the film transport mechanism shall be consistent with good design practice determined by the type of film to be used. A minimum diameter of one inch shall be used.

3.9.2.4 Film Loading: The camera shall be capable of being loaded in subdued light using live film protected by 30 feet of leader.

3.9.2.5 Loss of Overlap During Camera Start: The allowance for loss of overlap during any starting of the film transport mechanism shall be a maximum of [redacted] frames. From the time the start sequence command is received, the camera system shall be up to speed in approximately [redacted] seconds.

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3.9.3 Supply and Take-up Spools

3.9.3.1 Capacity: Approximately 7500 feet of thin-base Estar 5-inch film (3-1/2 mil) (weight 75 pounds). A constraint on film capacity is that the recovery capsule of the system can only accommodate a film spool approximately [redacted] inches in diameter.

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3.9.3.2 Interchangeability: Spools will be removable and interchangeable between cameras.

[redacted]

3.9.3.3 Flanges: The flanges will be removable from the hub.

3.9.4 Cassette

3.9.4.1 Basic Design: The cassette will consist of the take-up spool and film take-up drive systems for the panoramic camera mounted in a unit structure to allow installation in the recovery system. The panoramic take-up spool and drive shall be controlled by the panoramic camera film transport mechanism. Consideration will be given in the cassette design for spool removal in dark conditions. The total power consumption of the cassette shall be held to a minimum.

3.9.4.2 Configuration: The design of the cassette will conform to the basic configuration and space limitation as shown by Drawing Number T55-100. Provision will be made for mounting the cassette within the vehicle in accordance with the mounting provisions as shown in Drawing Number T55-100.

3.9.4.3 Instrumentation

3.9.4.3.1 Thermal Instrumentation: One Ruge BN 2400 resistance thermometer will be installed in the cassette.

3.9.4.3.2 Maximum Temperature Indicator: A passive method of indicating maximum temperature in excess of [redacted] degrees F experienced by the take-up spool will be provided.

3.9.4.3.3 Remote Film Footage Indication Requirement: The panoramic take-up spool shall be provided with a transducer and the necessary electrical connections to permit remote indication of the amount of 5-inch film that is on the [redacted] take-up spool at any time during the operation. This shall be accurate within 5 percent over the total spool radius.

3.9.4.4 Design Requirements:

3.9.4.4.1 Cassette Weight: The weight of the complete cassette with empty spools without film shall be held to a minimum and shall not exceed 20 pounds.

3.9.4.4.2 Film Loading: The cassette shall be assembled with polyester leader attached to the spool and threaded through the film handling system with six feet of

[redacted]

leader external to the cassette film entrance slot. This leader shall be spliced to the camera film for final assembly and testing purposes.

3.9.4.4.3 Film Capacity: The cassette shall contain a film spool of special design with a minimum diameter core and a [redacted] diameter flange capable of handling a film capacity of 19-15/16 inch diameter. The spacing between flanges shall be 5.0 ± 0.005 inches at the hub. Total run-in shall not exceed 0.030 inches at any point.

3.9.4.4.4 Panoramic Anti-Backup Device: The cassette shall be designed to incorporate a brake in the spool drive system to prevent the take-up spool from unwinding. This brake shall be capable of being released for test and checkout purposes by applying 28 volts DC on an appropriate pin connection. The brake shall be mechanically engaged when the voltage is removed.

3.9.4.4.5 Cassette Heaters: Heaters and associated thermostats required to maintain $70^{\circ} \pm 10^{\circ}F$ cassette temperature will be an SE responsibility. Itek will provide wiring within the cassette for the heaters.

3.9.4.5 Panoramic Take-up Performance: The take-up shall be capable of taking up the required amount of film as specified and shall be able to be started and stopped at least three hundred times during the taking up of a complete four-day roll of film under simulated duty cycle. The acceleration time shall be such that no slack loop will be formed during camera system operation. Film tension shall at all times be maintained between [redacted] pounds.

3.9.5 Optical System: Specification MIL-STD-150 shall be used as a guide in the design, manufacturing, and testing of the 66-inch lens.

3.9.5.1 Optical Characteristics: The optical characteristics of the lens, mirror, and filter shall meet the photo quality requirements of paragraph 3.4.1 when using the photographic film supplied per paragraph 3.9.1.

3.9.5.2 Lens: The panoramic camera lens is a 66-inch f/5 modified Tessar (Hyac type). The resolution shall approach diffraction limited performance at high contrast. Each lens will have focal length of 66 ± 0.25 inch. Custom lens/film plane assemblies may be required and hence need not be interchangeable. The lenses shall be

calibrated so that nodal points will be nearly coincident with the axis of rotation and the focal length will be maintained at operational altitude and temperature of 70 $\pm$ 10 degrees F (see paragraph 3.5.3.2).

3.9.5.3 Cell: [redacted] or other suitable material cell will house the optical elements.

3.9.5.4 Stereo Mirror: The mirror shall not contribute a significant loss to the optical system. Every effort shall be made to minimize temperature gradients through thermal design, specifying shielding, etc.

3.9.6 Photographic Filter: A photographic filter shall be mounted in the optical path. This filter shall not degrade the photographic image when the camera is used for its intended purpose. The filter shall be of the proper value for the selected film emulsion to be used as a haze filter (similar to Wratten 12).

3.9.7 Scanning Drive and Shutter Mechanism: A scan drive and shutter mechanism will be provided to drive the lens and exposure slit in synchronism. Scanning speed and scan cycling rate will be proportional to V/h and will be designed to provide approximately 10 percent overlap, at the nadir, between successive frames. Scanning speed during exposure will be held constant to meet the requirements of paragraph 3.8.3 and 3.8.4 to provide good positional determination and to minimize IMC error. The lens will be in a latched position during launch.

3.9.8 Stereo Mirror Drive: The mirror and drive will be capable of providing for vertical photography and a fore and aft stereo convergence angle of up to [redacted] degrees (i.e., [redacted] degrees of vertical). The drive will tilt the mirror either fore or aft (in the stereo mode) and maintain its position fixed during scan. In the vertical mode, the drive will simply tilt the mirror to center position and hold it there. The mirror will be in stow position during launch.

3.9.9 Image Motion Compensation System: The cameras will be designed for a median V/h = [redacted] radian/second. Upon receipt of proper IMC function selection, the system will compensate for ground motion and change cycling rate in such a manner as to maintain design overlap within the operating range. Frame to frame cycling times range from approximately [redacted] seconds over the design V/h range.

3.9.10 Exposure: Exposure shall be accomplished by utilizing a focal plane shutter. Exposure time may be varied by installing a fixed slit of appropriate width prior to flight. Four (4) slits

[redacted]

will be provided in the exposure range of [redacted] in increments of approximately 1 f-stop.

3.9.11 Fiducial and Shrinkage Markers: Fiducial and shrinkage marks will be per Drawing 43704.

3.9.12 Telemetering Data Transducers: In accordance with SP2-156, Electrical Interface.

4.0 TEST REQUIREMENTS

4.1 General: The tests listed are to be performed in accordance with the requirements stated within this specification.

4.1.1 Test Location: Itek Laboratories, Lexington, Massachusetts.

4.1.2 Witnessing of Tests: Tests may be witnessed by the following:

System Engineering (SE)

Itek-authorized representatives

Other personnel designated by customer.

4.1.3 Records of Tests and Reports: Test data shall be recorded. The contractor shall prepare test reports covering the results of tests required in this specification referencing the results of each test to the applicable test specified herein. The acceptance test shall be reported to SE.

4.2 Acceptance Tests: Acceptance tests shall be run on production units to verify workmanship and operability. The individual tests shall be run with no adjustments or repairs during the course of the test. If any modifications or repairs are made following the completion of any acceptance test, all tests previously run on the unit must be repeated, unless an explicit waiver is granted by SE, based on the demonstration that the modification or repair will not affect the response to the particular test or tests.

4.3 Acceptance Test Minimum Requirements: The Pan cameras will be tested for acceptance in accordance with acceptance test specification 49976.

4.3.1 Mating Test: The camera will be placed on a test fixture simulating the mechanical interfaces. This test fixture will be a precision instrument and the camera must fit the interface without alteration of the fixture. The camera system must align on all axes and must operate in accordance with this specification.

4.3.2 Functional Operation Test: With the simulated electrical interface of the checkout console, the camera will operate satisfactorily and respond to simulated commands. The camera shall be loaded with film and operated in both vertical and stereo modes in the horizontal attitude. The total film load shall be the maximum amount. At least 25 percent of the total film capacity should be operated through the camera during acceptance tests. This amount of film shall operate satisfactorily during the test without an assist of any manner whatsoever. The camera shall be started and stopped at least twenty-five times without any erratic operation or mishandling of film. Any malfunctions of loops, tracking or dancer rollers may be corrected, but the complete test shall be re-run.

4.3.3 Vibration Test: The camera mounted on the test fixture shall be placed on a vibration table and tests shall be run at prevailing room conditions. Test levels shall be selected such that levels attained will simulate those experienced during launch. After test, the camera shall be inspected for any visual defects. The equipment shall operate after being subjected to vibration in each of three mutually perpendicular axes, at a level of 1/2 to 1 g peak-to-peak using a frequency sweep program from 20 to 2000 cps at constant octave rate for a sweep time of 15 minutes, followed by a sweep from 2000 cps to 20 cps. The camera shall be operated for at least 100 cycles at maximum cycling rate following vibration. The optical resolution shall be measured in vacuum conditions following the vibration testing.

4.3.4 Electrical Insulation Tests: All electrical circuits shall be checked to the frame of the camera with a single application of 100 volts DC on 28-volt circuits and 300 volts DC on 115-volt circuits, and shall show a resistance of 1 megohm or greater. The wire harness shall be tested to the limits of 1072045 prior to the connection of subassemblies and components using 1000 volts DC megger limits.

4.3.5 Resolution Test: The camera shall be mounted in a fixture in the dynamic resolution tester using moving resolution targets described in paragraph 3.8.1. The camera shall be loaded with a test spool of unexposed film. The camera shall be operated and photograph the test patterns under dynamic conditions, to demonstrate satisfactory operation of the IMC control system and perform resolution tests in

accordance with paragraph 3.8.1.

4.3.6 Fogging and Format Test: During operation of the camera, simulated auxiliary photo recording data shall be fed to the camera auxiliary data recording system. This data shall be examined upon developing of the film, to ascertain satisfactory operation.

4.3.6.1 Format Inspection: The length, width, and spacing of the format shall be measured to ascertain that these dimensions are within the design accuracy. The film shall be examined to ascertain that the fiducial and shrinkage marks are clear and readily discernible.

4.3.6.2 Light Tightness: A fogging test of live film will be administered to demonstrate the light tightness of the Panoramic Camera Subsystem per paragraph 3.5.3.3.

5.0 PREPARATION FOR DELIVERY

5.1 Packing and Packaging: Packing and packaging shall be adequate to protect all equipment when shipped or stored.

5.2 Handling, Mating, and Checkout: Adequate protective devices will be supplied.

APPENDIX A

Exceptions to 2.0 APPLICABLE DOCUMENTS

1.0 EXCEPTIONS TO 6117B

a. Change paragraph 1.1.5 to read "AET Engineering Department of Contractor."

b. Delete paragraph 1.2.2.1 and substitute "Equipment shall be transported by military transport aircraft and motor vans. The equipment shall be protected and packaged to withstand such conditions as well as shock and vibration prevalent during shipping."

c. Delete paragraph 1.2.3 and substitute "Contractor storage facilities will ordinarily be air-conditioned. However, heat and high humidity may occur, and equipment should be able to withstand such conditions."

d. Delete paragraphs 1.2.4.1, 3.2.1.4, 3.2.1.5, 4.3.1, 4.4, 4.6, 4.7, and 4.8.

e. Change paragraph 2.1 to read "MIL-E-5272C (ASG)-13 April 1959 and Amendment No. 1, 20 January 1960 - Environmental Testing, Aeronautical and Associated Equipment, General Specification for" - all other MIL standards not applicable.

f. Delete paragraph 2.4.

g. Delete paragraphs 3.2.1, 3.2.2.2, and 3.2.2.3.

h. Change paragraph 4.1.1 to read "humidity of not more than 70 percent".

i. Paragraphs 4.8 through 4.8.3 - not applicable.

j. Delete paragraph 4.9.1 and 4.9.2.

k. Delete paragraph 4.10.1.

l. Table VI - not applicable.

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m. Paragraph 4.10.2 will be used as a guide in preparing the Qualification Test Specification, Procedures, and design of the qualification fixtures.

2.0 EXCEPTIONS TO 447969A

2.1 The following techniques, which have proved effective in the past will be employed for grounding and shielding and will satisfy the general intent of 447969A and the requirements of Specification 55155.

2.1.1 The chassis will in no case be used as a circuit path. There will be a minimum isolation of 1 megohm between chassis and all power and signal circuits.

2.1.2 Loads on each power category will be kept separated throughout the camera. That is, regulated return, unregulated return, 400-cycle return and TM return will not tie to each other in the camera.

2.1.3 No attempt will be made to float electronic chassis with respect to the structure.

2.1.4 Each electronic chassis will be tied electrically to a central chassis ground point.

2.1.5 All 400-cycle circuits will be run twisted shielded.

2.1.6 All shields at the interface, if picked up in the camera, will be carried through interface connectors to the load or signal source without commoning to other shield circuits and without being tied to any power return circuit or chassis.

2.1.7 Connector pins will be allocated to maintain spacing between power and signal circuits.

2.1.8 Shields will be grounded at but a single point. Shields will be insulated from each other in cable bundles.

2.1.9 Power distribution to subsystems not essential to the primary flight objective will be fused.

2.1.10 Wire sizes will be selected consistent with MIL-W-8160C.

2.1.11 Radio interference criteria will be applied for the entire camera rather than on a component or subassembly basis.

2.1.12 The overall schematic will show the shields and grounds distribution details.

2.1.13 New designs will incorporate wherever feasible, the techniques outlined in 447969A.

2.1.14 The following techniques will be employed in the camera to reduce radio interference at its source.

2.1.14.1 Dual LC filters will be used in conjunction with all DC motors.

2.1.14.2 Diodes or arc suppressors will be used to reduce inductive transients on relay coils, brakes, and solenoids.

2.1.14.3 Mounts for motors, etc. are spot-faced to provide good contact with the frame.